Internal electric field effects at ordered $Ga_{0.5}In_{0.5}P$/GaAs heterointerface investigated by photoreflectance spectroscopy

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Recently, it has been suggested that long-range ordering in $Ga_{0.5}In_{0.5}P$ leads a strong internal electric field and carrier accumulation at the heterointerface with GaAs.[1] Investigations of relations among atomic ordering, electric field, and carrier accumulation are very important for applications in electric devices. In this study, we performed photoreflectance (PR) spectroscopy of long-range ordered $Ga_{0.5}In_{0.5}P$ and GaAs heterointerfaces. Clear Franz-Keldysh oscillations (FKOs) due to the strong internal electric field were observed in the ordered samples. Furthermore, we found that the PR-signal amplitude strongly depends on atomic ordering.

Figure 1 shows PR spectra obtained from disordered and ordered $Ga_{0.5}In_{0.5}P$/GaAs heterointerfaces at 12 K. A FKO period of the ordered sample is larger than that of the disordered sample. This result reveals that the long-range ordering induces a strong electric field of ~240 kV/cm at the heterointerface, which is consistent with our previous results of photoluminescence-excitation measurements. On the other hand, the signal amplitude for the ordered sample is ~ 10 % of that for the disordered sample. Figure 2 shows dependence of the signal amplitude on modulating-light density (P_m). The signal amplitude for the ordered sample shows a superlinear dependence on $\ln P_m$, while the amplitude for the disordered sample is proportional to $\ln P_m$. Generally, this superlinear dependence appears under low modulating-carrier density or small built-in potential.[2] Because of the strong internal electric field in the ordered sample, it is considered that the superlinear dependence of the signal amplitude comes from the low modulating-carrier density. One of the considerable scenarios for the low modulating-carrier density is that excited carrier lifetime by the modulating light in the ordered sample is smaller than that at the disordered one. Raman-scattering measurements reveal clear plasmon-phonon coupled modes caused by a spontaneous carrier accumulation at the heterointerface. The accumulated carrier density is over 10^{12} cm^{-2}, which affects the carrier lifetime.

[1] K. Yamashita et al., in *Proceedings of 12th International Conference on Indium Phosphide and Related Materials*, (IEEE, 2000) p. 154.
[2] T. Kanata-Kita et al., J. Appl. Phys. **68**, 5309 (1990).

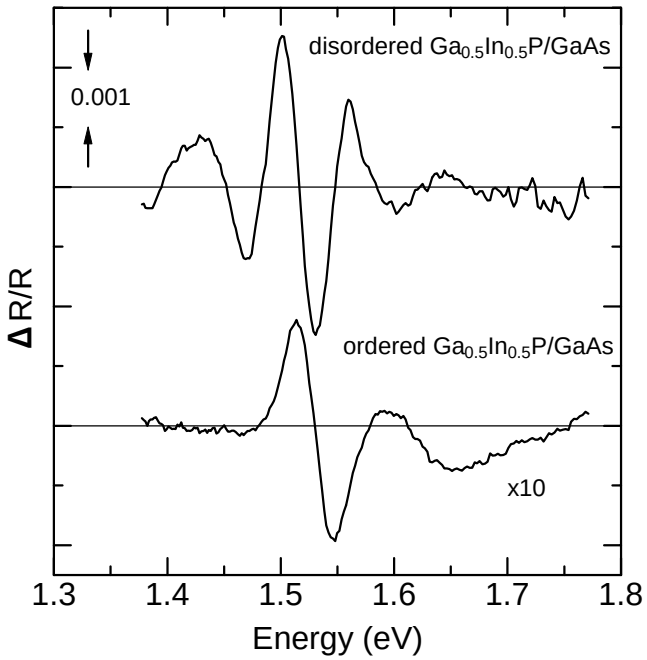

Figure 1 Photoreflectance spectra from disordered and ordered $Ga_{0.5}In_{0.5}P$ and GaAs heterointerface at 12 K. A modulating light was a 676-nm line of a Kr^+ laser. Modulating-light densities were 0.5 and 0.2 W/cm^2 for disordered and ordered samples, respectively.

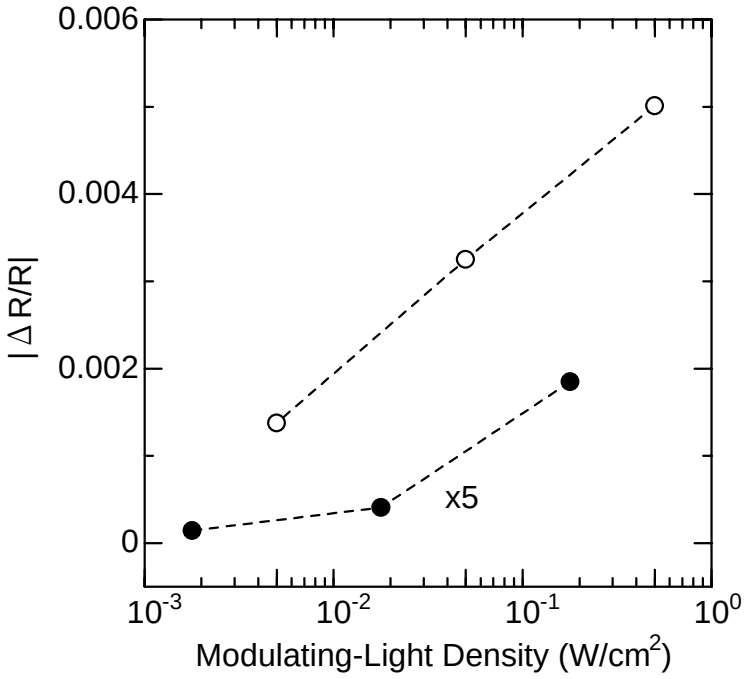

Figure 2 Dependence of PR-signal amplitudes on modulating-light density for ordered and disordered $Ga_{0.5}In_{0.5}P$/GaAs heterointerface plotted by closed and open circles, respectively